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SHORT COMMUNICATION

Screening of African Rice, *Oryza glaberrima* Steud, for Resistance to the African Rice Gall Midge *Orseolia oryzivora* Harris and Gagné

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Abstract—Two hundred seventy-three lines of the cultivated African rice species *Oryza glaberrima* Steud were screened in a paddy screenhouse at the National Cereals Research Institute, near Bida, Niger State, Nigeria for resistance to the African rice gall midge, *Orseolia oryzivora* Harris and Gagné, an increasingly important pest of lowland rice in Nigeria. Twenty entries which showed no galls in the screenhouse evaluation were retested under natural infestation in a gall midge-endemic field location near Abakaliki, Ebonyi State. Whereas the susceptible check variety, FARO 37, had 39.6 % of tillers infested 60 days after transplanting, damage in the test entries ranged from 0 to 3.7 %, an indication that they were all highly to moderately resistant to the pest. Greater host plant resistance is a central requirement for more effective management of *O. oryzivora*. Using resistance genes from *O. glaberrima* is a promising approach to achieving this.

Key Words: *Orseolia oryzivora*, *Oryza glaberrima*, resistance screening, Nigeria, African rice gall midge

Résumé—A l'Institut National de Recherche sur les Céréales de Bida (Niger State) au Nigéria, 263 lignées d'une espèce de riz africain cultivé *Oryza glaberrima* Steud, ont été évaluées en serre pour leur résistance à l'attaque par le moucheron à galle, *Oryseolia oryzivora* Harris and Gagné, un ravageur de plus en plus important dans les rizières de basses altitudes du Nigéria. Vingt entrées n'ayant pas montré de trace de galle en serre ont été ensuite testées sous des conditions d'infestations naturelles, dans un champs près d'Abakaliki (Ebonyi State), où la galle est reconnue endémique. Au moment où la variété (FARO 37) sensible de référence, avait 39,6% de talles infestées 60 jours après transplantation du riz, le taux d'attaque chez les entrées testées se rangeait entre 0 et 3,7%; ce qui était une indication sur la présence des entrées allant de hautement à moyennement résistantes au ravageur. Une très haute résistance de la plante constitue un préalable important pour une meilleure gestion de *O. oryzivora*. L'utilisation des gènes de résistance de *O. glaberrima* constituerait une approche prometteuse pour arriver à ce résultat.

Mots Clés: moucheron africain à galle, Nigéria, *Oryza glaberrima*, *Oryseolia oryzivora*, sélection pour la résistance

Introduction

The African rice gall midge (ARGM), *Orseolia oryzivora* Harris and Gagné, is an increasingly important insect pest of lowland rice in Nigeria (Ukwungwu et al., 1989). Since the first major outbreak in 1988, it has ravaged rice fields in the guinea savanna and humid forest zones, resulting at times in complete yield losses (Ukwungwu et al., 1989; Ukwungwu and Joshi, 1992b). Several measures to manage ARGM have been advocated (Brenière, 1983; Ukwungu, 1990; Joshi et al., 1990; Umeh et al., 1992). Of these, the

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use of resistant rice varieties appears to offer the most cost-effective component for incorporation into an integrated management strategy for this pest.

Varieties of *Oryza sativa* L. with high levels of resistance to ARGM are not available at present. Even those with high resistance to the closely related Asian rice gall midge *Orseolia oryzae* (Wood-Mason) are moderately to highly susceptible under heavy ARGM pressure (Ukwungwu and Joshi, 1992a; William and Ukwungwu, unpublished). Cisadane, a variety under test in ARGM-endemic areas in Nigeria, has useful level of tolerance to ARGM—for a given level of infestation, yield losses are lower in this variety than on other varieties (Williams, unpublished). However, this variety appears to have little of the antixenotic or antibiotic resistance needed to reduce the pest's ability to multiply rapidly on the crop under favourable environmental conditions.

Unlike *Oryza sativa,* which was introduced to East Africa from Asia probably around the first century AD and reached West Africa sometime between the ninth and sixteenth centuries (Ng et al., 1991), the African cultivated rice species, *Oryza glaberrima* Steud evolved in West Africa. It probably originated in the Middle Niger Delta some 3500 years ago (Hardcastle, 1959; Grist, 1975; Ng et al., 1991). Since its introduction, *O. sativa* has steadily replaced *O. glaberrima* in West Africa, mainly due to its higher yield potential. In Nigeria, *O. glaberrima* cultivation is now limited to some deep flooded plains of the Sokoto-Rima basin and a few other pockets of deep swamp around the country. The popularity it enjoys in these areas lies in its stable yield, tolerance to stresses and its distinctive taste.

Apparently very high levels of resistance to ARGM exist among traditional land races of *O. glaberrima* (Ukwungwu, 1986; Ukwungwu and Alam, 1991). Concerted screenhouse and field screening to identify these sources of resistance is being undertaken. Some of the results are presented in this paper.

Materials and Methods

The *O. glaberrima* lines tested were supplied by the Genetic Resources Unit (GRU) of the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria. They are referred to by their GRU accession numbers. These lines were tested in a screenhouse at the National Cereals Research Institute (NCRI), Badeggi, 18 km east of Bida, Niger State, and in a farmer's field in an ARGM hot spot at Okputimo, 30 km south of Abakaliki, Ebonyi State. Badeggi is in the guinea savanna agroecological zone and Okputimo in the forest/savanna transition zone.

Screenhouse tests

Evaluations were carried out in 1992 and 1994 in a 36 x 8 m tunnel screenhouse built in an irrigated rice field. To establish an ARGM infestation, an *O. sativa* variety highly susceptible to ARGM, FARO 37 (ITA 306), was grown in the screenhouse in a 0.5 x 36 m band along two sides, and infested with ARGM adults reared from galls collected in naturally-infested plots nearby. The ARGM were introduced over a two-week period, from 7 to 21 days after FARO 37 was transplanted, and the population then left to build up. Forty days after transplanting (DAT) FARO 37, 253 test entries were transplanted in the remaining space. An augmented design was used, with FARO 37 planted every 10th row as the susceptible check, and three single-row replicates of each test entry. Hill spacing was 15 cm within rows and 20 cm between rows, each row having 15 hills. ARGM damage was scored at 45 DAT by counting tillers with galls and total tillers per hill. The data were used to determine the percentage of tillers infested, and from this, the rice gall midge resistance scored according to the International Rice Research Institute's (IRRI) Standard Evaluation System for Rice (IRRI, 1988).

In 1994, another set of 20 *O. glaberrima* lines were tested in the screenhouse.

Field screening

Twenty of the *O. glaberrima* lines which gave promising results in the screenhouse tests were screened on-farm under natural ARGM infestation in a rainfed lowland rice field at Okputimo in 1995, along with 60 *O. sativa* lines. Variety TOG 6630 of *O. glaberrima* was not tested. Test entries were planted as three randomised complete blocks. Hill spacing was 20 x 20 cm. Each plot was 0.4 x 3 m, consisting of two rows of 15 hills each. Two *O. sativa* check varieties, the highly susceptible FARO 37 and the less susceptible Cisadane, were replicated systematically every 10 test lines. Basal fertiliser of 40 kg N, 40 kg P_2O_5 and 40 kg K_2O per ha was applied immediately before transplanting on August 11. Top-dressings, each of 20 kg N per ha, were applied at 20 DAT and 40 DAT, after hand-weeding. Counts of tillers with galls and

Table 1. African rice gall midge infestation on 20 *Oryza glaberrima* and two *O. sativa* check varieties in field screening trials at Okputimo, Ebonyi State, Nigeria; 1995 wet season

	20 DAT		40 DAT		60 DAT	
Entry	% tiller infestation[1]	Resistance ranking[2]	% tiller infestation	Resistance ranking	% tiller infestation	Resistance ranking
Oryza glaberrima						
TOG 7677	0.0	HR	0.5 (0.31)	R	0.0	HR
TOG 7189	0.0	HR	0.0	HR	0.0	HR
TOG 6730	0.0	HR	1.1 (0.75)	MR	0.0	HR
TOG 6542	0.0	HR	0.0	HR	0.0	HR
TOG 6582	0.6 (0.56)	R	0.4 (0.40)	R	0.0	HR
TOG 6472	2.7 (1.47)	MR	0.7 (0.35)	R	0.0	HR
TOG 6508	0.0	HR	0.4 (0.38)	R	0.0	HR
TOG 6597	0.0	HR	0.7 (0.68)	R	0.0	HR
TOG 6629	0.5 (0.46)	R	2.5 (1.49)	MR	0.0	HR
TOG 7442	0.0	HR	1.7 (1.23)	MR	0.0	HR
TOG 7684	0.0	HR	0.0	HR	0.0	HR
TOG 6342	0.0	HR	1.0 (0.54)	MR	0.0	HR
TOG 6346	0.0	HR	0.8 (0.83)	R	0.0	HR
TOG 6631	0.0	HR	0.0	HR	0.2 (0.23)	R
TOG 6539	0.0	HR	0.6 (0.36)	R	0.3 (0.28)	R
TOG 6339	0.0	HR	0.0	HR	0.3 (0.33)	R
TOG 6489	0.0	HR	0.0	HR	0.7 (0.67)	R
TOG 6216	0.9 (0.89)	R	0.2 (0.23)	R	0.9 (0.86)	R
TOG 6589	1.3 (0.68)	MR	0.3 (0.34)	R	1.7 (1.67)	MR
TOG 5860	0.8 (0.46)	R	5.7 (1.41)	MS	3.7 (2.69)	MR
Oryza sativa check varieties (n = 24):						
FARO 37	11.5 (0.87)	S	19.5 (0.75)	S	39.6 (1.36)	HS
Cisadane	10.1 (0.82)	MS	14.1 (0.93)	S	30.9 (1.32)	HS

[1]Mean and (SE).
[2]Resistance ranking, under Standard Evaluation System for Rice (IRRI, 1988): HR, Highly resistant; R, Resistant; MR, Moderately resistant; MS, Moderately susceptible; S, Susceptible; HS, Highly susceptible.
DAT, days after transplanting.

total tillers were taken for 20 hills in each plot at 20, 40 and 60 DAT and percent tiller infestation levels and SES scores determined.

Results

Screenhouse tests

Of the total of 253 *O. glaberrima* entries evaluated in the screenhouse in 1992, percent hill infestation ranged from 0.0 to 88.9, while percent tiller infestation ranged from 0.0 to 24.3. The susceptible check, FARO 37, had 15.6% and 75.0% tiller and hill infestation respectively. Twenty entries showed no galls at all. These were: TOG 5860, TOG 6216, TOG 6339, TOG 6342, TOG 6346, TOG 6472, TOG 6489, TOG 6508, TOG 6539, TOG 6542, TOG 6589, TOG 6597, TOG 6629, TOG 6630, TOG 6631, TOG 6730, TOG 7189, TOG 7442, TOG 7677, TOG 7684.

In the 1994 trial, percentage of tillers infested ranged from 0.0 to 22.2. All the entries except TOG 6582 were susceptible.

Field screening

In the 1995 field trial of the lines which showed no galls in the screenhouse tests, mean percent infested tillers at 20, 40 and 60 DAT ranged from 0 to 2.7, 0 to 5.7 and 0 to 3.7, respectively (Table 1). On the susceptible check FARO 37 the mean infestation levels were 11.5, 19.5 and 39.6% respectively on the three score dates, indicating that ARGM infestation pressure at the study site was heavy and prolonged. Even the most resistant of the 60 *O. sativa* test entries had 9.9 % of tillers infested by 60 DAT. Because of the large number of zero values, the data for the *O. glaberrima* lines did not show a normal distribution, so an analysis of variance was not carried out on them. On the SES scale, all the 20 lines rated highly to moderately resistant (Table 1).

Discussion

This study identified 20 lines of *O. glaberrima* with moderate to high resistance to ARGM at two test locations in Nigeria. It appears to be much easier to find a strong ARGM resistance in this rice species than in *O. sativa*. This is probably so because, unlike *O. sativa*, which is a more recent introduction from Asia, *O. glaberrima* has co-evolved with ARGM since its cultivation began in Africa over 3000 years ago.

However, it is known that populations of Asian rice gall midge from different parts of Asia differ in their abilities to overcome resistance genes in the host (Heinrichs and Pathak, 1981). Preliminary results of an ongoing study by the authors and other members of WARDA's Integrated Pest Management Task Force suggest that the same is true of ARGM. It is therefore necessary to test the stability across locations of the resistance found in these *O. glaberrima* lines.

The genetic potential of *O. glaberrima* as a good source of genes for resistance and/or tolerance to several other serious biotic and edaphic stresses to rice has been successfully exploited by the West Africa Rice Development Association (WARDA) in the production of fertile hybrids between *O. glaberrima* and *O. sativa* (Jones, 1995). It is hoped that new varieties incorporating genes from *O. glaberrima* will have enhanced potential to resist rice pests peculiar to Africa, in particular ARGM and rice yellow mottle virus (RYMV).

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